

1 APPLICATION FOR UNITED STATES LETTERS PATENT

2 ON INVENTION FOR:

3 HYDROFOIL SYSTEM FOR LIFTING A BOAT PARTIALLY OUT OF WATER
4 AN AMOUNT SUFFICIENT TO REDUCE DRAG

5 BY INVENTOR: Raimer Tossavainen

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7 Agt. Doc. No.: TOSR18A

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15 TO ALL WHOM IT MAY CONCERN:

16 BE IT KNOWN that I, Raimer Tossavainen, a citizen of
17 FINLAND and resident of: Lakebay, WA 98349 have invented
18 certain new and useful improvements in a(n): HYDROFOIL
19 SYSTEM FOR LIFTING A BOAT PARTIALLY OUT OF WATER AN AMOUNT
20 SUFFICIENT TO REDUCE DRAG of which the following is a full,
21 clear, concise and exact description:

1 Inventor: Raimer Tossavainen
2 Invention: HYDROFOIL SYSTEM FOR LIFTING A BOAT PARTIALLY OUT OF WATER
3 AN AMOUNT SUFFICIENT TO REDUCE DRAG
4 DOC. No.: TOSR18A

5 BACKGROUND OF THE INVENTION

6 Field of the Invention:

7 The present invention relates to a hydrofoil system. More
8 particularly, the present invention relates to a hydrofoil system for
9 lifting a boat out of water an amount sufficient to reduce drag while
10 still allowing the boat to be powered by a conventional inboard-outboard
11 drive.

12 Description of the Prior Art:

13 Numerous innovations for hydrofoils have been provided in the prior
14 art that will be described. Even though these innovations may be suitable
15 for the specific individual purposes to which they address, however, they
16 differ from the present invention.

17 A FIRST EXAMPLE, U.S. Patent No. 3,092,062 to Savitsky teaches in
18 combination with a water borne vessel, a passive self-compensating
19 hydrofoil control system comprising a substantially vertical hydrofoil
20 strut member and a hydrofoil plane, said vertical strut member being
21 connected at its upper end to the hull of said vessel, said hydrofoil
22 plane being disposed at the lower end of said strut member and operable
23 to maintain a hydrodynamic lift of the vessel to a minimum submergence of
24 the hydrofoil plane below the free water surface at cruise speed of the
25 vessel, each of said strut and plane members having integral pivotal flaps
26 defining at least a portion of the trailing edges of said members, said
27 pivotal flap of the strut member terminating at its lower end at a height
28 above said hydrofoil plane which is greater than said minimum submergence,

1 and mechanical linkage means interconnecting both of said pivotal flaps
2 and operable, on application of unbalanced external forces to one flap
3 causing it to pivot, to apply to the other flap a force acting to move
4 said other flap toward a position for equalizing the forces applied to
5 both flaps.

6 A SECOND EXAMPLE, U.S. Patent No. 3,577,948 to Frey teaches an
7 attachment for a power boat which fits on the transom or stern of the boat
8 and comprises a pair of trim tabs hinged at the transom and extending
9 rearwardly therefrom, and which may be swung vertically simultaneously to
10 different angular positions to trim the boat so that it operates at the
11 proper attitude regardless of its loading. The tabs are so formed that
12 they also bring about lateral stability as well as impart the proper
13 attitude to the boat. Furthermore, the tabs are positively moved
14 vertically up or down to their selected angular positions.

15 A THIRD EXAMPLE, U.S. Patent No. 3,651,775 to Kock teaches a
16 hydrofoil system attached to a hull of a vessel. The foil are attached
17 to the hull of a vessel by means of non-lifting struts and each foil
18 comprises a main lifting foil portion which consists of submerged middle
19 section and two upwardly and outwardly inclined side sections which
20 control the end position of the lift. In a spaced relation and parallel
21 to the inclined sections, two auxiliary upper lifting foil portions are
22 attached on each side of the hull for supporting the lifting action and
23 stabilizing the vessel.

24 A FOURTH EXAMPLE, U.S. Patent No. 4,756,265 to Lane teaches a thrust
25 collar for mounting around the upper portion of the propeller of an
26 inboard/outboard engine. Each thrust collar supports a horizontal
27 hydrofoil wing extending laterally from the collar. A second, similar
28 wing can be provided on an opposing side of the collar. Where the collar
29 is used in pairs on paired engines on a catamaran hull, a single hydrofoil
30 wing can be supported between the thrust collars. The thrust collar is
31 preferably used in conjunction with hull lifting structures. One hull
32 mounted hydrofoil structure is supported at the lower end of the strut

1 extending and includes a generally curvilinear gull-wing shaped lower
2 surface. For V-type hulls, a pair of elongated mechanical lifting
3 structures, symmetrically positioned on either side of the keel
4 substantially in the vicinity of the keel are attached to the hull so as
5 to extend generally traversely to the sloping side surfaces of the hull
6 intersecting at the keel. These lifting structures have a length many
7 times greater than their maximum transverse dimension and preferably
8 extend from a position approximately a midship beneath the hull to the
9 stern of the hull. Retractable hydrofoil assemblies are described for
10 drawing a strut supporting a hydrofoil wing into a boat or rotating the
11 strut upward into a tunnel beneath the boat in the case of a catamaran
12 hull.

13 A FIFTH EXAMPLE, U.S. Patent No. 4,915,048 to Stanford teaches
14 planing vessels of improved performance capability and methods for
15 improving such performance and foils which may be associated with planing
16 vessels for providing improved performance capability. A dynamic downward
17 force generated as the vessel moves through water, preferably by a foil,
18 is imposed on the vessel, with the locus of the force positioned, in the
19 traverse direction, at the longitudinal vertical centerline plane of the
20 vessel. In the longitudinal direction the locus of the dynamic force is
21 positioned, relative to the other forces acting fore-to-aft on the vessel,
22 to decrease the trim angle of the vessel, desirably to less than two
23 degrees. Vessel wetted surface configurations are provided for stable and
24 efficient operation at low trim angles, including the following. A deep
25 draft, fine entrance which minimizes rise at the bow experienced with
26 conventional planing vessels and assists in maintaining laminarity of flow
27 at the planing surfaces. A foil extending along the bowpeak below the
28 waterline and spaced forwardly thereof to streamline the flow passing the
29 bow to thereby decrease spray and turbulence. A skeg extending downward
30 at the bottom of the hull at the entrance along the longitudinal
31 centerline plane which improves directional stability and also assists in
32 maintaining flow laminarity. A swept back wing located at the entrance,

1 preferably mounted at the lower margin of the skeg positioned with an
2 angle of attack which generates an upward force to improve the vessel
3 stability against pitch and yaw in disturbed water. An aftmidships
4 planing floor having a rise from midships to the stern trailing edge
5 desirably from 50% to 100% of the midships draft improves the stability
6 of the vessel when operated at trim. A release floor extending aftward
7 5 to 25% of the waterline length of the vessel, preferably from a
8 transverse step and rising over this length 10 to 50% of the midships
9 draft to a transverse trailing edge. The trailing edge and the release
10 floor, in the transverse direction, are parallel with base plane of the
11 vessel. The pressure release floor reduces the pressure on the aftward
12 flow to separation at the trailing edge in a gradual and uniform manner
13 which reduces drag. The foil to generate a downward force in the flow
14 desirably is positioned below the stern trailing edge and contoured to
15 produce minimum induced drag and to divert the flow at its trailing edge
16 downwardly so as to reduce turbulence and drag at the stern.

17 A SIXTH EXAMPLE, U.S. Patent No. 5,404,830 to Ligozio teaches a
18 displacement boat hull having the outboard surfaces of its wetted portion
19 designed with a deep-V shape, and having at least one pair of retractable
20 hydrofoil fins positioned in respective pockets along those outboard
21 surfaces at a predetermined distance above the keel. When extended, the
22 fins are positioned at fixed angles relative to the hull, and at least one
23 pair of fins is positioned in proximity to the stern. In a preferred
24 embodiment, a conventional deep-V semi-displacement hull is modified to
25 increase the conventional maximum draft with an unusually steep angle (at
26 least 30 degrees to 40 degrees) for the initial deadrise from the keel
27 upward toward the chine; and at least two pairs of fins are disposed on
28 opposite sides of the hull, with an aft pair being positioned in proximity
29 to the stern and another pair being positioned forward of the stern pair,
30 preferably just forward of the boat's center of balance. The fins are
31 continuously adjustable from (a) a fully-retracted in-pocket position to
32 a fully-extended position laterally outboard of the hull. The invention

1 can be used to modify catamaran and tri-hulls as well as mono-hulls, and
2 it is compatible with all types of propulsion systems. Such modifications
3 provide a remarkably low center of gravity that assures excellent balance
4 and stability at all times, particularly when operating with the fins,
5 while achieving higher speeds and requiring less power.

6 A SEVENTH EXAMPLE, U.S. Patent No. 6,164,235 to Hoppe teaches a
7 hydrofoil equipment water craft comprising at least one hull member,
8 terminating at a bow and a stern, a front hydrofoil member arranged in the
9 zone of the bow of the hull, at least partially below the hull; and a rear
10 hydrofoil member positioned to the rear of the longitudinal center of
11 gravity (LCG) of the hull, the front hydrofoil member being at least
12 partially offset transversely relative to the rear hydrofoil member so
13 that the front hydrofoil or rear hydrofoil are at least partially disposed
14 in separate longitudinal flow streams.

15 AN EIGHTH EXAMPLE, U.S. Patent No. 6,354,237 B1 to Gaynor et al.
16 teaches a trim tab control system in which four buttons or switches are
17 provided for the marine operator in which the operator can select to raise
18 the bow, raise the stern, raise the port side of the boat, or raise the
19 stern side of the boat in relative terms, and the system will
20 automatically position the trim tabs to most efficiently achieve the
21 operator's demanded change in position of the marine vessel.

22 It is apparent that numerous innovations for hydrofoils have been
23 provided in the prior art that are adapted to be used. Furthermore, even
24 though these innovations may be suitable for the specific individual
25 purposes to which they address, however, they would not be suitable for
26 the purposes of the present invention as heretofore described.

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SUMMARY OF THE INVENTION

2 ACCORDINGLY, AN OBJECT of the present invention is to provide a
3 hydrofoil system for lifting a boat out of water an amount sufficient to
4 reduce drag while still allowing the boat to be powered by a conventional
5 inboard-outboard drive that avoids the disadvantages of the prior art.

6 ANOTHER OBJECT of the present invention is to provide a hydrofoil
7 system for lifting a boat out of water an amount sufficient to reduce drag
8 while still allowing the boat to be powered by a conventional inboard-
9 outboard drive that is simple and inexpensive to manufacture.

10 STILL ANOTHER OBJECT of the present invention is to provide a
11 hydrofoil system for lifting a boat out of water an amount sufficient to
12 reduce drag while still allowing the boat to be powered by a conventional
13 inboard-outboard drive that is simple to use.

14 BRIEFLY STATED, STILL YET ANOTHER OBJECT of the present invention
15 is to provide a hydrofoil system for lifting a boat out of water an amount
16 sufficient to reduce drag while still allowing the boat to be powered by
17 a conventional inboard-outboard drive. The hydrofoil system includes a
18 front hydrofoil unit, a center hydrofoil unit, and a pair of rear
19 hydrofoil units. The front hydrofoil unit includes a hydrofoil portion
20 that dependingly mounts to a mounting portion thereof that depends from
21 the bottom of the hull at the bow thereof. The center hydrofoil unit
22 includes a hydrofoil that dependingly extends equidistantly outwardly from
23 a pair of stanchions thereof that depend from the bottom of the hull at
24 the substantial center thereof. Each rear hydrofoil unit includes a
25 hydrofoil that dependingly extends equidistantly outwardly from a pair of
26 stanchions thereof that depend from port and starboard trim tab units of
27 the hull, respectively.

28 The novel features which are considered characteristic of the
29 present invention are set forth in the appended claims. The invention
30 itself, however, both as to its construction and its method of operation,
31 together with additional objects and advantages thereof, will be best

- 1 understood from the following description of the specific embodiments when
- 2 read and understood in connection with the accompanying drawing.

2 The figures of the drawing are briefly described as follows:

3 FIGURE 1 is a diagrammatic perspective view of the present invention
4 installed on a hull of a boat;

5 FIGURE 2 is an enlarged diagrammatic side elevational view taken
6 generally in the direction of arrow 2 in figure 1 of the front
7 hydrofoil unit of the present invention;

8 FIGURE 3 is diagrammatic rear elevational view taken generally in the
9 direction of arrow 3 in figure 2 of the mounting point of the
10 front hydrofoil unit of the present invention;

11 FIGURE 4 is a diagrammatic perspective view of the area generally
12 pointed to by arrow 4 in figure 2 of the hydrofoil portion of
13 the front hydrofoil unit of the present invention;

14 FIGURE 5 is an enlarged diagrammatic cross sectional view taken along
15 line 5-5 in figure 1 of the center hydrofoil unit of the
16 present invention;

17 FIGURE 6 is an enlarged diagrammatic rear elevational view taken
18 generally in the direction of arrow 6 in figure 1 of the pair
19 of rear hydrofoil units of the present invention;

20 FIGURE 7 is a diagrammatic side elevational view taken generally in the
21 direction of arrow 7 in figure 6 of a rear hydrofoil unit of
22 the present invention; and

23 FIGURE 8 is an enlarged diagrammatic perspective view, taken generally
24 in the direction of arrow 8 in figure 7, of the hydrofoil
25 portion of a rear hydrofoil unit of the present invention.

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LIST OF REFERENCE NUMERALS UTILIZED IN THE DRAWING

2 10 hydrofoil system of present invention for lifting boat 12 out of
3 water 14 amount sufficient to reduce drag while still allowing
4 boat 12 to be powered by conventional inboard-outboard drive 16
5 12 boat
6 14 water
7 16 conventional inboard-outboard drive
8 18 hull of boat 12
9 20 bottom of hull 18 of boat 12
10 22 bow of hull 18 of boat 12
11 24 stern of hull 18 of boat 12
12 25 substantial center of hull 18 of boat 12
13 26 port and starboard trim tabs of stern 24 of hull 18 of boat 12
14 28 front hydrofoil unit for depending from bottom 20 of hull 18 of
15 boat 12 at bow 22 thereof
16 30 center hydrofoil unit for depending from bottom 20 of hull 18 of
17 boat 12 at substantial center 25 thereof
18 32 pair of rear hydrofoil units for depending from port and
19 starboard trim tab units 26 of stern 24 of hull 18 of boat 12,
20 respectively
21 34 mounting portion of front hydrofoil unit 28 for mounting to, and
22 for depending from, bottom 20 of hull 18 of boat 12 at bow 22
23 thereof
24 36 hydrofoil portion of front hydrofoil unit 28
25 38 pair of upper plates of mounting portion 34 of front hydrofoil
26 unit 28 for mounting to, and for depending from, bottom 20 of
27 hull 18 of boat 12 at bow 22 thereof
28 40 common edge of pair of upper plates 38 of mounting portion 34 of
29 front hydrofoil unit 28
30 41 through bores in pair of upper plates 38 of mounting portion 34
31 of front hydrofoil unit 28

1 42 stanchion of mounting portion 34 of front hydrofoil unit 28
2 44 lower plate of mounting portion 34 of front hydrofoil unit 28
3 45 through bores in lower plate 44 of mounting portion 34 of front
4 hydrofoil unit 28
5 46 pair of struts of mounting portion 34 of front hydrofoil unit 28
6 48 upper plate of hydrofoil portion 36 of front hydrofoil unit 28
7 50 through bores in upper plate 40 of hydrofoil portion 36 of front
8 hydrofoil unit 28
9 52 upper bolts
10 54 extension of hydrofoil portion 36 of front hydrofoil unit 28
11 56 lower plate of hydrofoil portion 36 of front hydrofoil unit 28
12 58 through bores in lower plate 56 of hydrofoil portion 36 of front
13 hydrofoil unit 28
14 60 stanchion of hydrofoil portion 36 of front hydrofoil unit 28
15 62 through bores in stanchion 60 of hydrofoil portion 36 of front
16 hydrofoil unit 28
17 64 lower bolts
18 66 hydrofoil of hydrofoil portion 36 of front hydrofoil unit 28
19 68 pair of stanchions of center hydrofoil unit 30 for mounting to,
20 for depending from, and for straddling, bottom 20 of hull 18 of
21 boat 12 at substantial center 25 thereof
22 70 hydrofoil of center hydrofoil unit 30
23 72 pair of stanchions of each rear hydrofoil unit of pair of rear
24 hydrofoil units 32 for mounting to, and for depending from,
25 associated one of port and starboard trim tabs 26 of rear 24 of
26 hull 18 of boat 12
27 74 hydrofoil of each rear hydrofoil unit of pair of rear hydrofoil
28 units 32
29 76 vertical portion of each stanchion of pair of stanchions 72 of
30 each rear hydrofoil unit of pair of rear hydrofoil units 32
31 78 horizontal portion of each stanchion of pair of stanchions 72 of
32 each rear hydrofoil unit of pair of rear hydrofoil units 32

1 80 through bores in horizontal portion 78 of each stanchion of pair
2 of stanchions 72 of each rear hydrofoil unit of pair of rear
3 hydrofoil units 32 for receiving screws (not shown) for attaching
4 pair of rear hydrofoil units 32 to port and starboard trim tabs
5 26, respectively.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

2 Referring now to the figures, in which like numerals indicate like
3 parts, and particularly to figure 1, the hydrofoil system of the present
4 invention is shown generally at 10 for lifting a boat 12 out of water 14
5 an amount sufficient to reduce drag while still allowing the boat 12 to
6 be powered by a conventional inboard-outboard drive 16. The boat 12 has
7 a hull 18 with a bottom 20, a bow 22, a stern 24 with port and starboard
8 trim tabs 26, and a substantial center 25 which is intermediate the bow
9 22 of the hull 18 and the stern 24 of the hull 18.

10 The hydrofoil system 10 comprises a front hydrofoil unit 28, a
11 center hydrofoil unit 30, and a pair of rear hydrofoil units 32. The
12 front hydrofoil unit 28 is for depending from the bottom 20 of the hull
13 18 at the bow 22 thereof. The pair of rear hydrofoil units 32 are for
14 depending from the port and starboard trim tab units 26 of the hull 18,
15 respectively. The center hydrofoil unit 30 is for depending from the
16 bottom 20 of the hull 18 at the substantial center 25 thereof.

17 The overall configuration of the front hydrofoil unit 28 can best
18 be seen in figure 2, and as such, will be discussed with reference
19 thereto.

20 The front hydrofoil unit 28 comprises a mounting portion 34 and a
21 hydrofoil portion 36. The mounting portion 34 of the front hydrofoil unit
22 28 is for mounting to, and for depending from, the bottom 20 of the hull
23 18 at the bow 22 thereof. The hydrofoil portion 36 of the front hydrofoil
24 unit 28 mounts to, and depends from, the mounting portion 34 of the front
25 hydrofoil unit 28.

26 The specific configuration of the mounting portion 34 of the front
27 hydrofoil unit 28 can best be seen in figures 2 and 3, and as such, will
28 be discussed with reference thereto.

29 The mounting portion 34 of the front hydrofoil unit 28 comprises a
30 pair of upper plates 38. The pair of upper plates 38 of the mounting
31 portion 34 of the front hydrofoil unit 28 are disposed in a V-shape along

1 a common edge 40 thereof, are for mounting to, and for depending from, the
2 bottom 20 of the hull 18 at the bow 22 thereof, and have through bores 41
3 for this purpose.

4 The mounting portion 34 of the front hydrofoil unit 28 further
5 comprises a stanchion 42. The stanchion 42 of the mounting portion 34 of
6 the front hydrofoil unit 28 depends along the common edge 40 of the pair
7 of upper plates 38 of the mounting portion 34 of the front hydrofoil unit
8 28.

9 The mounting portion 34 of the front hydrofoil unit 28 further
10 comprises a lower plate 44. The lower plate 44 of the mounting portion
11 34 of the front hydrofoil unit 28 depends from the stanchion 42 of the
12 mounting portion 34 of the front hydrofoil unit 28 and contains through
13 bores 45.

14 The mounting portion 34 of the front hydrofoil unit 28 further
15 comprises a pair of struts 46. The pair of struts 46 of the mounting
16 portion 34 of the front hydrofoil unit 28 extend from the pair of upper
17 plates 38 of the mounting portion 34 of the front hydrofoil unit 28 to the
18 lower plate 44 of the mounting portion 34 of the front hydrofoil unit 28,
19 respectively.

20 The specific configuration of the hydrofoil portion 36 of the front
21 hydrofoil unit 28 can best be seen in figures 2 and 4, and as such, will
22 be discussed with reference thereto.

23 The hydrofoil portion 36 of the front hydrofoil unit 28 comprises
24 an upper plate 48. The upper plate 48 of the hydrofoil portion 36 of the
25 front hydrofoil unit 28 attaches to, and depends from, the lower plate 44
26 of the mounting portion 34 of the front hydrofoil unit 28 and contains
27 through bores 50 that align with the through bores 45 in the lower plate
28 44 of the mounting portion 34 of the front hydrofoil unit 28 so as to form
29 aligned through bores that receive upper bolts 52.

30 The hydrofoil portion 36 of the front hydrofoil unit 28 further
31 comprises an extension 54. The extension 54 of the hydrofoil portion 36

1 of the front hydrofoil unit 28 depends from the upper plate 48 of the
2 hydrofoil portion 36 of the front hydrofoil unit 28.

3 The hydrofoil portion 36 of the front hydrofoil unit 28 further
4 comprises a lower plate 56. The lower plate 56 of the hydrofoil portion
5 36 of the front hydrofoil unit 28 depends from the extension 54 of the
6 hydrofoil portion 36 of the front hydrofoil unit 28 and has through bores
7 58.

8 The hydrofoil portion 36 of the front hydrofoil unit 28 further
9 comprises a stanchion 60. The stanchion 60 of the hydrofoil portion 36
10 of the front hydrofoil unit 28 attaches to, and depends from, the lower
11 plate 56 of the hydrofoil portion 36 of the front hydrofoil unit 28 and
12 has through bores 62 that align with the through bores 58 in the lower
13 plate 56 of the hydrofoil portion 36 of the front hydrofoil unit 28 so as
14 to form aligned through bores that receive lower bolts 64.

15 The hydrofoil portion 36 of the front hydrofoil unit 28 further
16 comprises a hydrofoil 66. The hydrofoil 66 of the hydrofoil portion 36
17 of the front hydrofoil unit 28 depends from, and extends equidistantly out
18 from, the stanchion 60 of the hydrofoil portion 36 of the front hydrofoil
19 unit 28.

20 The specific configuration of the center hydrofoil unit 30 can best
21 be seen in figure 5, and as such, will be discussed with reference
22 thereto.

23 The center hydrofoil unit 30 comprises a pair of stanchions 68 and
24 a hydrofoil 70. The pair of stanchions 68 of the center hydrofoil unit
25 30 are for mounting to, for depending from, and for straddling, the bottom
26 20 of the hull 18 at the substantial center 25 thereof.

27 The hydrofoil 70 of the center hydrofoil unit 30 depends from, and
28 extends equidistantly outwardly from, the pair of stanchions 68 of the
29 center hydrofoil unit 30.

30 The specific configuration of each of the pair of rear hydrofoil
31 units 32 can best be seen in figure 6-8, and as such, will be discussed
32 with reference thereto.

1 Each rear hydrofoil unit 32 comprises a pair of stanchions 72 and
2 a hydrofoil 74. The pair of stanchions 72 of each rear hydrofoil unit 32
3 are for mounting to, and for depending from, an associated one of the port
4 and starboard trim tabs 26.

5 Each stanchion 72 of each rear hydrofoil unit 32 is inverted L-
6 shaped, and has a vertical portion 76 and a horizontal portion 78 that
7 extends outwardly from the vertical portion 76 thereof. The horizontal
8 portion 78 of each stanchion 72 of each rear hydrofoil unit 32 has through
9 bores 80 for receiving screws (not shown) for attaching the pair of rear
10 hydrofoil units 32 to the port and starboard trim tabs 26, respectively.

11 The hydrofoil 74 of each rear hydrofoil unit 32 depends from, and
12 extends equidistantly outwardly from, the pair of stanchions 72 of an
13 associated rear hydrofoil unit 32.

14 It will be understood that each of the elements described above, or
15 two or more together, may also find a useful application in other types
16 of constructions differing from the types described above.

17 While the invention has been illustrated and described as embodied
18 in a hydrofoil system for lifting a boat out of water an amount sufficient
19 to reduce drag while still allowing the boat to be powered by a
20 conventional inboard-outboard drive, however, it is not limited to the
21 details shown, since it will be understood that various omissions,
22 modifications, substitutions and changes in the forms and details of the
23 device illustrated and its operation can be made by those skilled in the
24 art without departing in any way from the spirit of the present invention.

25 Without further analysis, the foregoing will so fully reveal the
26 gist of the present invention that others can, by applying current
27 knowledge, readily adapt it for various applications without omitting
28 features that, from the standpoint of prior art, fairly constitute
29 characteristics of the generic or specific aspects of this invention.